ABSTRACT

The relative surface area sizes of portions having distinct phase-shift and transmission of light of a pattern on a phase-shift mask substantially obey the condition that the product of surface area and transmission of the electrical field strength is the same for all of the portions. Then, frequency doubling occurs due to vanishing zero order diffraction orders and in the case of high-transition attenuated phase-shift masks a large first order diffraction amplitude reveals an even an improved as compared with conventional phase-shift masks. Two-dimensional matrix-like structures particularly on attenuated or halftone phase-shift masks can be arranged to image high-density patterns on a semiconductor wafer. The duty cycles of pattern matrices can be chosen being different from one in two orthogonal directions nevertheless leading to frequency doubling.